WHAT WE CLAIM IS:

1. A precision soft-touch gripping mechanism for flat objects comprising:
a mounting plate attachable to an external transportation means;
a linear precision drive mechanism supported by said mounting plate;
at least three gripping posts with at least two of them moveable simultaneously radially inwardly/outwardly with respect to an imaginary or real circular flat object having a plane and a circular peripheral edge, said at least three gripping posts having a plane and embracing said circular peripheral edge from opposite sides; and
a gripping force control means for controlling the gripping force with which said gripping posts grip said peripheral edge by controlling operation of said linear precision drive mechanism.

2. The precision soft-touch gripping mechanism of Claim 1, wherein said at least three gripping posts comprise:
a first gripping post which has at least one gripping element for engaging said peripheral edge from one side thereof, said precision soft-touch gripping mechanism having a longitudinal axis that passes through said precision drive mechanism and said first gripping element;
a second gripping post and a third gripping post which are located on the side of said gripping mechanism opposite to said first gripping post and on both sides with respect to said longitudinal axis.

3. The precision soft-touch gripping mechanism of Claim 2 further comprising a first linking member having means for supporting said first gripping post, a second linking member having means for pivotally supporting said second gripping post, and a third linking member having means for pivotally supporting said third gripping post, said second linking member and said third linking member being pivotally connected to said first linking member, at least said second linking member and said third linking

member being connected to said precision drive mechanism via said gripping force control means.

4. The precision soft-touch gripping mechanism of Claim 3, wherein said precision drive mechanism comprises a stepper motor, and wherein said second gripping post comprises at least one first gripping roller and said third gripping post comprises at least one second gripping roller.

5. The precision soft-touch gripping mechanism of Claim 4, wherein said means for supporting said first gripping post comprises a first arm connected to said stepper motor through said gripping force control means, said means for pivotally supporting said at least one first roller comprising a first arm pivotally attached to said second linking member and said means for pivotally supporting said at least one second roller comprises a second arm pivotally attached to said first linking member, and first spring means for urging said first arm with said first gripping roller in a direction toward said peripheral edge and a second spring means for urging said second arm with said second gripping roller in a direction toward said peripheral edge, said at least first gripping roller and said at least second gripping roller having means for supporting them rotatingly.

6. The precision soft-touch gripping mechanism of Claim 4, wherein said stepper motor has an actuating member, said gripping force control means comprises a sliding member moveable in the direction of said longitudinal axis, a main spring means located between said actuating member and said sliding member, and a means for controlling compression of said main spring means in terms of said gripping force.

7. The precision soft-touch gripping mechanism of Claim 6, wherein said main spring means is a coil spring, said means for controlling compression of said main spring is a pressure sensor connected to said stepper motor

for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

8. The precision soft-touch gripping mechanism of Claim 6, wherein said main spring means is a coil spring, said means for controlling compression of said main spring is limit switch connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

9. The precision soft-touch gripping mechanism of Claim 5, wherein said stepper motor has an actuating member, said gripping force control means comprises a sliding member moveable in the direction of said longitudinal axis, a main spring means located between said actuating member and said sliding member, and a means for controlling compression of said main spring means in terms of said gripping force.

10. The precision soft-touch gripping mechanism of Claim 9, wherein said main spring means is a coil spring, said means for controlling compression of said main spring is a pressure sensor connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

11. The precision soft-touch gripping mechanism of Claim 9, wherein said main spring means is a coil spring, said means for controlling compression of said main spring is limit switch connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

12. The precision soft-touch gripping mechanism of Claim 5, wherein said first spring means comprises a first leaf spring, said second spring means comprises a second leaf spring, said first leaf spring has a first sensor for

measuring compression of said first leaf spring, and said second leaf spring has a second sensor for measuring compression of said second leaf spring, said first sensor and said second sensor being connected to said stepper motor for stopping operation of said stepper motor when either of said first leaf spring and said second leaf spring is compressed to a predetermined gripping force.

13. The precision soft-touch gripping mechanism of Claim 1, further comprising sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object and sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object.

14. The precision soft-touch gripping mechanism of Claim 13, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

15. The precision soft-touch gripping mechanism of Claim 4, further comprising sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object and sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object.

16. The precision soft-touch gripping mechanism of Claim 15, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of

destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

17. The precision soft-touch gripping mechanism of Claim 7, further comprising sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object and sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object.

18. The precision soft-touch gripping mechanism of Claim 17, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

19. The precision soft-touch gripping mechanism of Claim 8, further comprising sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object and sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object.

20. The precision soft-touch gripping mechanism of Claim 19, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

21. A soft-touch gripping mechanism for flat objects comprising:

a mounting plate attachable to an arm of a mechanical robot;

a stepper motor supported by said mounting plate, said stepper motor having output member for use as an actuating member;

three gripping posts moveable simultaneously radially inwardly/outwardly with respect to an imaginary or real circular flat object having a circular peripheral edge, said three gripping posts comprising a first gripping post located on a side of said imaginary or real circular flat object opposite to said stepper motor, a second gripping post comprising a first gripping roller and a second gr ipping roller, and a second gripping post comprising a third gripping roller and a fourth gripping roller, said first gripping roller, said second gripping roller, said third gripping roller, and said fourth gripping roller being located on a step motor side of said imaginary or real circular flat object, said soft-touch gripping mechanism having a longitudinal axis passing in the direction of said actuating member and through said first gripping post, said first gripping roller and said second gripping roller being located on one side of said longitudinal axis, and said third gripping roller and said fourth gripping roller being located on a side of said longitudinal axis opposite to said one side; and

a gripping force control means for controlling the gripping force with which said gripping posts grip said peripheral edge by controlling operation of said stepper.

22. The precision soft-touch gripping mechanism of Claim 21, further comprising sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object and sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object.

23. The precision soft-touch gripping mechanism of Claim 22, wherein said sensor means for determining position of said at least three gripping posts

substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

24. The precision soft-touch gripping mechanism of Claim 21, which comprises an end effector laying substantially in a plane and wherein said flat objects comprise semiconductor wafers of a circular shape, said end effector further comprising:

a first linking member having means for supporting said first gripping post, a second linking member having means for pivotally supporting said second gripping post with said first gripping roller and said second gripping roller, and a third linking member having means for pivotally supporting said third gripping post with said third gripping roller and said fourth gripping roller, said second linking member and said third linking member being pivotally connected to said first linking member, at least said second linking member and said third linking member being connected to said precision drive mechanism via said gripping force control means.

25. The precision soft-touch gripping mechanism of Claim 15, wherein said second linking member has a first arm pivotally connected to said second linking member, said third linking member has a second arm pivotally connected to said third linking member, said first arm rotatingly supports said first gripping roller and said second gripping roller, while said second arm rotatingly supports said third gripping roller and said fourth gripping roller;

a first leaf spring for urging said first arm with said first gripping roller and said second gripping roller in a direction toward said peripheral edge and a second leaf spring means for urging said second arm with said third

gripping roller and said fourth gripping roller in a direction toward said peripheral edge, said first gripping roller, said second gripping roller, said third gripping roller, and said fourth gripping roller being supported rotatingly.

26. The precision soft-touch gripping mechanism of Claim 25, further comprising sensor means for determining position of said plane of said end effector substantially with respect to said plane of said flat object and sensor means for determining that said plane of said end effector deviates from said plane of said flat object.

27. The precision soft-touch gripping mechanism of Claim 26, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

28. The precision soft-touch gripping mechanism of Claim 25, wherein said gripping force control means comprises a sliding member moveable in the direction of said longitudinal axis, a main spring located between said actuating member and said sliding member, and means for controlling compression of said main spring in terms of said gripping force.

29. The precision soft-touch gripping mechanism of Claim 28, wherein said main spring is a coil spring, said means for controlling compression of said main spring is a pressure sensor connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

30. The precision soft-touch gripping mechanism of Claim 28, wherein said springing means is a coil spring, said means for controlling compression of said spring is limit switch connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

31. The precision soft-touch gripping mechanism of Claim 25, wherein said first leaf spring has a first sensor for measuring compression of said first leaf spring, and said second leaf spring has a second sensor for measuring compression of said second leaf spring, said first sensor and said second sensor being connected to said stepper motor for stopping operation of said stepper motor when either of said first leaf spring and said second leaf spring is compressed to achieve said gripping force.

32. The precision soft-touch gripping mechanism of Claim 31, wherein said gripping force control means comprises a sliding member moveable in the direction of said longitudinal axis, a main spring located between said actuating member and said sliding member, and means for controlling compression of said main spring in terms of said gripping force.

33. The precision soft-touch gripping mechanism of Claim 32, wherein said main spring is a coil spring, said means for controlling compression of said main spring is a pressure sensor connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

34. The precision soft-touch gripping mechanism of Claim 32, wherein said springing means is a coil spring, said means for controlling compression of said spring is limit switch connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

35. The precision soft-touch gripping mechanism of Claim 28, wherein said first linking member that supports said first gripping post is stationary, said precision soft-touch gripping mechanism further comprising a first pivot rigidly connected to said base plate on said one side of said longitudinal axis, and a second pivot rigidly connected to said base plate on said side opposite to said one side, said second linking member being pivotally supported by said first pivot, said third linking member being pivotally supported by said second pivot, said sliding member having a first pin rigidly connected thereto, said second linking member and said third linking member have respective slots in the direction transverse to said longitudinal axis, said respective slots being at least partially overlapped, said first pin being slidingly guided in said respective slots.

36. The precision soft-touch gripping mechanism of Claim 35, wherein said gripping force control means comprises a sliding member moveable in the direction of said longitudinal axis, a main spring located between said actuating member and said sliding member, and means for controlling compression of said main spring in terms of said gripping force.

37. The precision soft-touch gripping mechanism of Claim36, wherein said main spring is a coil spring, said means for controlling compression of said main spring is a pressure sensor connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

38. The precision soft-touch gripping mechanism of Claim 36, wherein said springing means is a coil spring, said means for controlling compression of said spring is limit switch connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

39. The precision soft-touch gripping mechanism of Claim 35, further comprising sensor means for determining position of said plane of said end effector substantially with respect to said plane of said flat object and sensor means for determining that said plane of said end effector deviates from said plane of said flat object.

40. The precision soft-touch gripping mechanism of Claim 39, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

41. The precision soft-touch gripping mechanism of Claim 28, further comprising: a second pin rigidly connected to said sliding member and located on said one side of said longitudinal axis; a third pin rigidly connected to said sliding member and located on said side of said longitudinal axis opposite to said one side; a third pivot rigidly connected to said base plate, located on said longitudinal axis, and pivotally supporting said second linking member and said third linking member, said second linking member having a first slot in a direction transverse to said longitudinal axis, and said third linking member having a second slot in said direction transverse to said longitudinal axis, said second pin being slidingly guided in said first slot, and said third pin being slidingly guided in said second slot, said first linking member being stationary.

42. The precision soft-touch gripping mechanism of Claim 41, wherein said gripping force control means comprises a sliding member moveable in the direction of said longitudinal axis, a main spring located between said

actuating member and said sliding member, and means for controlling compression of said main spring in terms of said gripping force.

43. The precision soft-touch gripping mechanism of Claim 42, wherein said main spring is a coil spring, said means for controlling compression of said main spring is a pressure sensor connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

44. The precision soft-touch gripping mechanism of Claim 42, wherein said springing means is a coil spring, said means for controlling compression of said spring is limit switch connected to said stepper motor for stopping operation of said stepper motor when said coil spring is compressed with a predetermined force.

45. The precision soft-touch gripping mechanism of Claim 41, further comprising sensor means for determining position of said plane of said end effector substantially with respect to said plane of said flat object and sensor means for determining that said plane of said end effector deviates from said plane of said flat object.

46. The precision soft-touch gripping mechanism of Claim 45, wherein said sensor means for determining position of said at least three gripping posts substantially with respect to said plane of said flat object comprises at least one a mapping sensor for determining that the position of destination of said flat object is free for unloading said flat object and at least one through-beam sensor for determining position of the edge of said flat object.

47. The precision soft-touch gripping mechanism of Claim 22, wherein said sensor means for determining that said plane of said at least three

gripping posts deviates from said plane of said flat object comprises a pair of sensors, each comprising a light transmitter that emits a light beam and a light receiver that receives said light beam, said light emitter and light receiver being located on opposite sides of said longitudinal axis, the light beams of each of said sensors intersecting in the center of said circular flat object.

48. The precision soft-touch gripping mechanism of Claim 26, wherein said sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object comprises a pair of sensors, each comprising a light transmitter that emits a light beam and a light receiver that receives said light beam, said light emitter and light receiver being located on opposite sides of said longitudinal axis, the light beams of each of said sensors intersecting in the center of said circular flat object.

49. The precision soft-touch gripping mechanism of Claim 39, wherein said sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object comprises a pair of sensors, each comprising a light transmitter that emits a light beam and a light receiver that receives said light beam, said light emitter and light receiver being located on opposite sides of said longitudinal axis, the light beams of each of said sensors intersecting in the center of said circular flat object.

50. The precision soft-touch gripping mechanism of Claim 45, wherein said sensor means for determining that said plane of said at least three gripping posts deviates from said plane of said flat object comprises a pair of sensors, each comprising a light transmitter that emits a light beam and a light receiver that receives said light beam, said light emitter and light receiver being located on

opposite sides of said longitudinal axis, the light beams of each of said sensors intersecting in the center of said circular flat object.

51. A method for gripping and handling precision flat objects with soft touch comprising the steps of:

providing a precision soft-touch gripping mechanism comprising a linear precision drive mechanism, at least three gripping posts laying substantially in a plane with at least two of said three gripping posts being moveable by means of said linear precision drive mechanism with respect to an imaginary or real circular flat object having a circular peripheral edge, said at least three gripping posts embracing said circular peripheral edge from opposite sides, said flat object having a plane; gripping force control means for controlling the gripping force with which said gripping posts grip said peripheral edge by controlling operation of said linear precision drive mechanism, first sensor means for determining position of said plane of said at least three gripping posts substantially with respect to said plane of said flat object, and second sensor means for determining that said plane of said at least three deviates from said plane of said flat object;

checking a position of said three gripping posts with the use of said first sensor means;

checking a position of said three gripping posts with the use of said second sensor means;

initiating said linear precision drive mechanism for moving said at least two gripping posts toward said edge of said flat object;

dividing the path of movement of said at least two gripping posts towards said edge at least into a first stage which is an initial stage of said movement and a second stage which is a final stage of said movement; and

controlling operation of said linear precision drive mechanism via said gripping force control means so that in said first stage said at least two gripping posts move with a speed higher than at said second stage.